UCRL-JC-123027 Abs Rev 1

1. SUBMIT TO: SD97 (Conference Chair)

2. Submit each abstract to one conference

Soft X-Ray Lasers and Applications II, J. J. Rocca, L. B. DaSilva

3. ABSTRACT TITLE

X-ray laser coherence in the presence of density fluctuations

4. AUTHOR LISTING (principal author first)

R.P. Ratowsky, V.V. Kolosov*, A.A. Zemlyanov*, and R.A. London

Lawrence Livermore National Laboratory, Livermore, California 94550
USA
rpr@llnl.gov; rlondon@llnl.gov

*Institute of Atmospheric Optics, Siberian Branch of the Russian Academy of Sciences, Tomsk 634055 Russian Federation
zuev@iao.tomsk.su

5. PRESENTATION

Prefer Oral Presentation

6. ABSTRACT TEXT

We analyze the effect of plasma density fluctuations on x-ray laser coherence and discuss the implications of our results for exploding-foil x-ray laser experiments. We treat propagation of coherence using a deterministic ray–tracing technique based on the radiation transfer equation, coupled with the phase approximation of Huygens-Kirchhoff method to treat the random fluctuations. First we develop the propagation technique for the zero-fluctuation case, and derive analytical solutions for the intensity distribution and coherence function in the output plane of an active medium with parabolic transverse profiles of dielectric constant and gain coefficient. We discuss under what conditions we may include only the contribution of spontaneous sources adjacent to the far face of the active medium, and show that in many cases of interest it is necessary to take into account sources throughout the whole active medium. We then include density fluctuations, and obtain expressions for the coherence function for homogeneous fluctuations with both Gaussian and exponential correlation, as a function of fluctuation amplitude and correlation length. We apply our results, using parameters representative of both selenium and yttrium exploding foil x-ray lasers, where non-uniformity in the optical laser pump beams or hydrodynamic instabilities may lead to fluctuations. We show how

fluctuations can cause the coherence to saturate with increasing laser length, and indicate how a moderate level of fluctuations can explain the observed coherence in experiments on selenium x-ray lasers. We also characterize the sensitivity of the coherence to fluctuations by defining a critical amplitude level above which they dominate the coherence.

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

7. KEY WORDS
x-ray laser, inhomogeneous active media, fluctuations, degree of coherence, ray-tracing technique